

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau



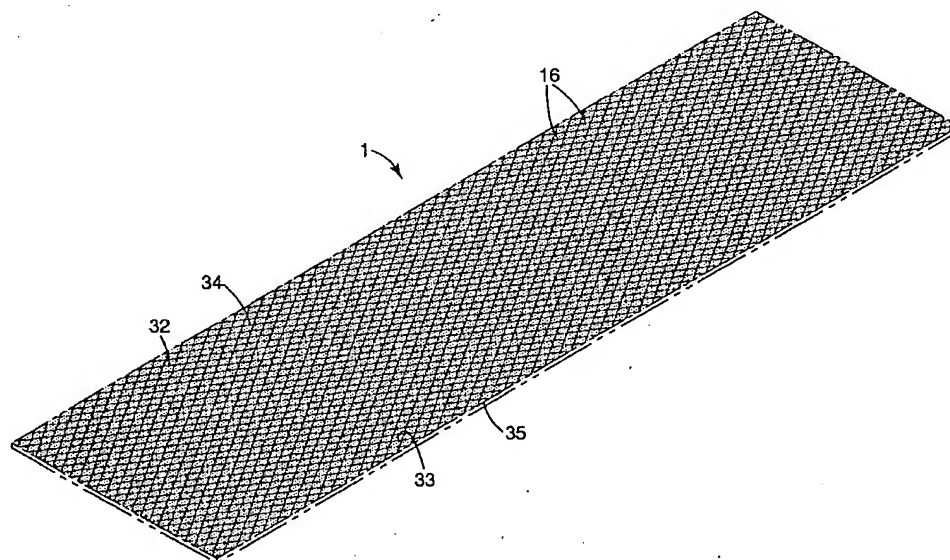
(43) International Publication Date
25 October 2001 (25.10.2001)

PCT

(10) International Publication Number
WO 01/79897 A2

- (51) International Patent Classification⁷: **G02B 5/124**
- (21) International Application Number: **PCT/US01/07341**
- (22) International Filing Date: **7 March 2001 (07.03.2001)**
- (25) Filing Language: **English**
- (26) Publication Language: **English**
- (30) Priority Data:
09/548,894 13 April 2000 (13.04.2000) **US**
- (71) Applicant: **3M INNOVATIVE PROPERTIES COMPANY** [US/US]; 3M Center, Post Office Box 33427, Saint Paul, MN 55133-3427 (US).
- (72) Inventors: **CODERRE, James, C.**; Post Office Box 33427, Saint Paul, MN 55133-3427 (US). **CHIRHART, Dennis, J.**; Post Office Box 33427, Saint Paul, MN 55133-3427 (US). **FRANK, John, W.**; Post Office Box 33427, Saint Paul, MN 55133-3427 (US). **JOHNSON, Stephen, A.**; Post Office Box 33427, Saint Paul, MN 55133-3427 (US). **MCGURRAN, Daniel, J.**; Post Office Box 33427, Saint Paul, MN 55133-3427 (US).
- (74) Agents: **HOFMANN, Rudolph, P., Jr.** et al.; Post Office Box 33427, Saint Paul, MN 55133-3427 (US).
- (81) Designated States (*national*): AE, AG, AL, AM, AT, AT (utility model), AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, CZ (utility model), DE, DE (utility model), DK, DK (utility model), DM, DZ, EE, EE (utility model), ES, FI, FI (utility model), GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (utility model), SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW.
- (84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).
- Published:
— without international search report and to be republished upon receipt of that report
- For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: **CUBE CORNER RETROREFLECTIVE ARTICLE WITH ENHANCED PIGMENTATION**



(57) Abstract: Retroreflective sheeting includes a transparent film, a pigmented layer having pigmented indicia thereon, and a retroreflective cube layer. The cube layer includes a number of cube corner elements bounded by at least two sets of intersecting grooves. A metallic film is disposed on at least some of the cube corner elements. The pigmented layer is interposed between the transparent film and the cube layer, and has pigmented indicia aligned with at least one of the sets of intersecting grooves.

WO 01/79897 A2

BEST AVAILABLE COPY

CUBE CORNER RETROREFLECTIVE ARTICLE WITH ENHANCED PIGMENTATION

BACKGROUND

5 The present invention relates generally to reflective articles. The invention has particular application to retroreflective sheeting with a multiplicity of cube corner elements.

 Retroreflective materials are configured to receive light rays impinging upon a viewing surface and so alter the rays that they are reflected back toward their sources. Retroreflective material is generally used to enhance low-light visibility of articles to which the retroreflective material is attached. Such material is used in a variety of applications ranging from traffic signs to bicycle reflectors. By enhancing low-light visibility, retroreflective materials enhance safety, provide decoration, and increase conspicuity in general.

15 Two known types of retroreflective material include microsphere-based sheeting and cube corner sheeting. Microsphere-based sheeting, sometimes referred to as "beaded" sheeting, employs a multitude of microspheres typically at least partially imbedded in a binder layer and having associated specular or diffuse reflecting materials (e.g., pigment particles, metal flakes, vapor coats) to retroreflect incident light. In general, however, such sheeting has a lower retroreflective efficiency than cube corner sheeting.

 Cube corner retroreflective sheeting comprises a body portion typically having a substantially planar viewing surface and a structured surface comprising a plurality of cube corner elements. Each cube corner element comprises three approximately mutually perpendicular optical faces that intersect at a cube apex or, where the cube apex is truncated, that otherwise converge at an uppermost portion. It is known to treat the structured surface with a specularly reflective coating to improve performance at high entrance angles. An example of this is vapor-coated retroreflective sheeting.

 Cube corner sheeting typically has a much higher retroreflectance than beaded sheeting, where retroreflectance is expressed in units of candelas per lux per square meter. However, certain graphics applications require not only high retroreflectance but high daytime "whiteness". The whiteness of an object is sometimes described in terms

of the second of the tristimulus coordinates (X,Y,Z) for the object, and thus is referred to as "cap-Y". The cap-Y scale ranges from 0 for a perfectly black object to 100 for a perfectly white object. The whiteness of an object is also sometimes described in terms of its "Luminance Factor", ranging from 0 to 1. If the daytime whiteness of cube corner sheeting could be increased, without substantially reducing retroreflectance, such sheeting could find broader application in graphics applications. Cube corner sheetings which have an aluminum or other metal vapor coat applied to the structured surface tend to have a somewhat grayish appearance, rather than white.

One way that the whiteness of cube corner sheeting has been increased in the past is by printing white ink on the sheeting. Such printing methods have included printing on the outside of the transparent overlay layer or printing on the structured surface of the cube layer. Although these methods have helped increase the whiteness of vapor coated cube corner sheeting, they tend to reduce or sacrifice the retroreflectiveness of the sheeting. Accordingly, the art seeks more durable, less expensive, easier to manufacture alternatives while reducing the sacrifice in retroreflectiveness.

SUMMARY

Retroreflective sheeting includes a transparent film, a pigmented layer having pigmented indicia thereon, and a retroreflective cube layer. The cube layer includes a number of cube corner elements bounded by at least two sets of intersecting grooves. A metallic film is disposed on at least some of the cube corner elements. The pigmented layer is interposed between the transparent film and the cube layer, and has pigmented indicia aligned with at least one of the sets of intersecting grooves.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1A is a top perspective view of a sheet of retroreflective material.

FIG. 1B is a top perspective view of another example of a sheet of retroreflective material.

FIG. 2 is a top plan view of a portion of the retroreflective sheet of Fig. 1A.

FIG. 3 is a top plan view of a portion of a retroreflective sheet of Fig. 1A.

FIG. 4 is a top plan view of a portion of a retroreflective sheet of Fig. 1A.

FIG. 5 is a cross-sectional elevation view of a retroreflective sheet of Fig. 1A.

DETAILED DESCRIPTION

FIG. 1A is a perspective view of a sheet 1 of retroreflective material having a multiplicity of cube corner elements. Sheet 1 shown in FIG. 1A is suitable for a number of applications including traffic signs, clothing, vehicle markings, and any other applications where increased conspicuity or retroreflection with graphics is desired. Sheet 1 includes an overlay layer 34 (shown in FIG. 5), a retroreflective layer, for example, cube layer 32 that includes viewing surface 33, and a structured surface 35 (shown in FIGS. 3 and 5). The sheet 1 also includes pigmented indicia 16 which appears in the example as intersecting sets of parallel lines. FIG. 1B is another example of a retroreflective material 1a where the cube layer 32a is arranged in multiple orientations and appears as two sets of longitudinal stripes 3a, 3b.

FIG. 2 shows a magnified plan view of the retroreflective sheeting as seen from viewing surface 33 where the structured surface 35 is visible in detail. Three sets of parallel grooves 4, 6, 8 are formed in the structured surface 35, defining cube corner elements 10 and 12 which each have three faces that converge at apexes 10a, 12a respectively. Apexes 10a, 12a protrude from structured surface 35 and are the rearmost extremities of elements 10, 12, and the "bottom" or "vertex" of grooves 4, 6, 8 (the front-most portion, where opposed groove side surfaces intersect) define triangular-shaped bases of elements 10, 12. The faces of cube corner element 10 comprise mutually perpendicular groove side surfaces 4a, 6a, 8a, and the faces of structure 12 comprise mutually perpendicular groove side surfaces 4b, 6b, 8b. For ease of illustration, only some of the side surfaces of grooves 4, 6, 8 are shown in FIG. 2.

The groove sets intersect each other at about 60 degree included angles. The faces of the cube corner elements are substantially smooth and, when metallized, are characterized by high specular reflectivity and small or negligible diffuse reflectivity. As illustrated, cube corner elements 10 and 12 are bounded by three sets of grooves, 4, 6, and 8. Cube corner elements bounded by two sets of grooves are also known.

FIG. 3 is a top plan view of a portion of a retroreflective sheet. For simplicity, a portion of retroreflective sheet 14 is shown defined by parallel grooves 4, 6, and 8. Although grooves 4, 6, and 8 are shown with angles of about 60 degrees, other suitable angles can be used. Sheet 14 includes pigmented indicia 16 that is shown in the form of two parallel markings 18 that are substantially aligned with grooves 4. Indicia 16 repeats

over the remainder of sheet 14 in order to enhance pigmentation for daytime viewing. In one example, indicia 16 is colored white to increase the cap Y value of sheet 14. Indicia 16 can include sets of dots, or other suitable shapes. In the example shown, such features are substantially aligned with at least one set of grooves 4, 6, or 8. By aligning indicia 16 with at least one set of grooves, less retroreflectivity is sacrificed for a given increase in pigmentation. Also, aligning indicia 16 with at least one set of grooves increases the retroreflectivity for a given amount of pigmentation over a unit of surface area. In the example of Fig. 1B, the indicia are aligned with at least one groove of one set of longitudinal stripes, for example stripes 3a. It is contemplated that the indicia are aligned with at least one groove of both sets of longitudinal stripes 3a, 3b.

FIG. 4 is a plan view of a portion of the retroreflective sheet of FIG. 1A. The portion of sheet 1 illustrated in FIG. 4 is similar to that of FIG. 3, except that pigmented indicia 16 comprises two sets of parallel stripes 18, 22, such as that shown in FIGS. 1A and 1B. In the embodiment shown in FIG. 4, each set of stripes is still substantially aligned with one of the groove sets 4, 6, 8. For example, stripes 18 are aligned with grooves 4, while stripes 22 are aligned with grooves 8 and extend the length of the sheet 1. Thus, stripes 16 and 18 intersect at an angle, θ (theta), which is substantially the same as the angle of intersection between grooves 4 and 8. Those skilled in the art will appreciate that pigmented indicia 16 may comprise as many sets of stripes as there are sets of grooves. In one example, stripes 16 and 18 have a uniform width ranging between 0.1 mm and about 2.0 mm. Additionally, it is preferred that the pigmented indicia cover a portion of the retroreflective surface ranging from 10% to 80% although other ranges are possible.

FIG. 5 is a cross-sectional elevation view of a retroreflective sheet 24 in accordance with an embodiment of the present invention. Sheet 24 includes base layer 26, adhesive layer 28, metallic layer 30, cube layer 32, and overlay layer 34. Preferably, base layer 26 is a liner such as a silicone coated release liner that is bonded to adhesive layer 28. In one example, adhesive layer 28 is a pressure sensitive adhesive, however adhesive layer 28 can be any suitable adhesive. One specific example is tackified acrylic pressure sensitive adhesive. Layer 28 is also adhered to metallic layer 30, which can be preferably a coating of vaporized aluminum that is deposited onto cube layer 32. Use of a suitable primer material such as a titanium metal sputter coated on cube layer 32 has

been found to enhance the adhesion of the vapor deposition. As is known, use of a metallic layer, such as layer 30, increases the entrance angularity of cube layer 32.

Cube layer 32 can be any suitable cube layer adapted to reflect light back towards its source, for example, the cube layer can be formed from a polycarbonate.

5 Alternatively, the cubes could be cast from an epoxy acrylate radiation curable resin. In one example, layer 32 includes substantially planar viewing surface 33 and structured surface 35 although other viewing surfaces are contemplated. Layer 32 can also include cube corner elements such as elements 10, 12, of FIG. 2, that are canted with respect to each other such that retroreflectivity is improved over a wider range in incident angles.

10 Overlay layer 34 includes substantially transparent cover film 36, pigmented layer 38, and pigmented indicia 16. In one example, layer 34 is constructed from layers of polyester and copolyester such as layers of polyethylene terephthalate and co-polyethylene terephthalate (PET/COPET). The term "co-polyethylene terephthalate" ("COPET") refers to a copolymer of polyethylene terephthalate and another monomer
15 such as isophthalate. The overlay 34 is formed by coextruding two resins. Exemplary polyester material includes commonly available from Eastman Chemical Company of Kingsport, TN. Exemplary copolyester material is available from Eastman Chemical Company of Kingsport, TN under the brand designations: Spectar Copolyester 14471; Eastar PCTG Copolyester 5445; and Eastar Copolyester GN071. A suitable copolyester
20 material is manufactured by Minnesota Mining and Manufacturing Company (3M) of St. Paul, MN and designated "80/20". In this example, layer 34 is a PET/COPET where layer 36 is PET and layer 38 is COPET. Layer 34 may be termed a "bilayer" where layer 34 comprises two layers. As can be seen, pigmented indicia 16 is disposed on a surface of overlay layer 34 that is protected from the elements. The disposition of this
25 pigmented indicia can be accomplished by the use of a rotogravure printing operation. Those skilled in this technology can readily design, cut a gravure cylinder, and print this COPET "bilayer" using this method. Alternatively, the pigmented indicia 16 can be disposed on cube layer 32.

30 Film 36 is adapted for outside exposure. Thus, film 36 can have resistance to ultraviolet light, water, and impact. Further, film 36 is also suitable for exposure to temperatures ranging from about -30 degrees Celsius to over 60 degrees Celsius. In one example, PET film 36 includes an ultraviolet (UV) stabilizer. For example, layer 36 can include a triazine UV absorber which is characterized by both broad-band UV

absorption, peaking between 300-360 nm and low volatility to provide a combination of low color, excellent permanence, high temperature stability and UV stability. One such triazine UV absorber is sold under the brand designation Cyasorb UV-1164 from Cytec Industries in Batavia, IL. In addition to, or instead of the UV stabilizer, another form of additive can be added to layer 36 to protect it from light. One example, of such an additive is a hindered amine light stabilizer (HALS). One set of HALS compositions are those containing polymeric compounds made of substituted hydroxypiperidines, including the polycondensation product of a hydroxypiperidines with succinic acid or with a triazine. A particular HALS compound is the polycondensation product of 1-(2-hydroxyethyl)-2,2,6,6-tetramethyl-4-hydroxypiperidine with succinic acid. One group of suitable HALS compositions are available commercially, for example, under the trade designation "Tinuvin" (such as "Tinuvin 622") available from Ciba of Tarrytown, New York. Additionally, the UV stabilizer and HALS can be used alone or in combination, and can be added to either, or both of the PET layer 36 and COPET layer 38.

Pigmented layer 38 is transparent and includes pigmented indicia 16. Layer 38 can be clear (uncolored) or it can be colored to add visual impact to sheet 24. For example, if sheet 24 will be used as a stop sign, layer 38 can be colored red. Alternatively, layers 36 and 38 can be colored. Also, the cube layer 32 can be colored. Preferably, the inner surface of the overlay is printed a color and covered with pigmented indicia 16. Layer 38 is preferably constructed from COPET and, in the example, is easier to print on than PET. In addition to the rotogravure method described above, the pigmented indicia 16 can be screen printed onto layer 38 in a manner known in the art. In one example, the ink used for indicia is vinyl based with titanium dioxide pigment that is compatible with the COPET layer on which it is printed.

Although layer 34 has been described as a PET/COPET bilayer, layer 34 can also be constructed from other materials such as polymethylmethacrylate (PMMA). In this example, layer 34 is a mono-layer. In an additional example, layer 34 is polyurethane. The monolayers can include additives. In the examples with monolayers, pigmented indicia are placed on the monolayer either on the outer surface of layer 34 or on the inner surface between layer 34 and cube layer 32.

Once pigmented indicia 16 is printed upon overlay layer 34, layer 34 is laminated, e.g., heat laminated, or otherwise attached to cube layer 32 to form retroreflective sheet 24. Such lamination can be effected in any suitable manner and is

known in the art. Heated lamination is particularly advantageous for retroreflective sheeting with a PET/COPET overlay. When the indicia is printed upon the COPET layer, solvent in the ink can cause some crystallization of the COPET layer, and thus cloud the layer to some extent. Re-heating the crystalline COPET (such as during a heated lamination) can convert it to an amorphous state and thus increase the clarity of the layer. Additionally, the bond between the PET layer and COPET layer can be enhanced when subjected to the heated lamination.

An exemplary retroreflective sheeting, in accordance with the teachings above was prepared as follows. A PMMA overlay film was printed with a vinyl-based ink having a titanium dioxide pigment. The print pattern was a crosshatch that was intentionally designed to align with the grooves of the cube layer. A polycarbonate cube layer was then prepared using standard thermal processing methods. The overlay layer was laminated to the cube layer using standard heat lamination techniques, while ensuring that the printed side of the overlay layer faced the cube layer, thus burying the printed indicia under the overlay. The opposite side of the cube layer was then primed by sputter-coating it with a metal primer such as a titanium. Once the priming was complete, a layer of vaporized aluminum was deposited upon the primed surface. Adhesive was applied to the metallized side of the cube layer to complete the retroreflective sheeting.

In another example, the same process was used, but a PET/COPET bilayer was substituted for the PMMA overlay layer. A PET/COPET bilayer has advantages over PMMA. For example, PET/COPET is typically less expensive than PMMA, and does not require an additional smoothing film when heat laminating the overlay to the cube layer. PET/COPET is also less brittle and thus less prone to fracturing.

Although the present invention has been described with reference to specific embodiments, workers skilled in the art will recognize that changes may be made in form and detail without departing from the spirit and scope of the invention, which are defined by the appended claims.

WHAT IS CLAIMED IS:

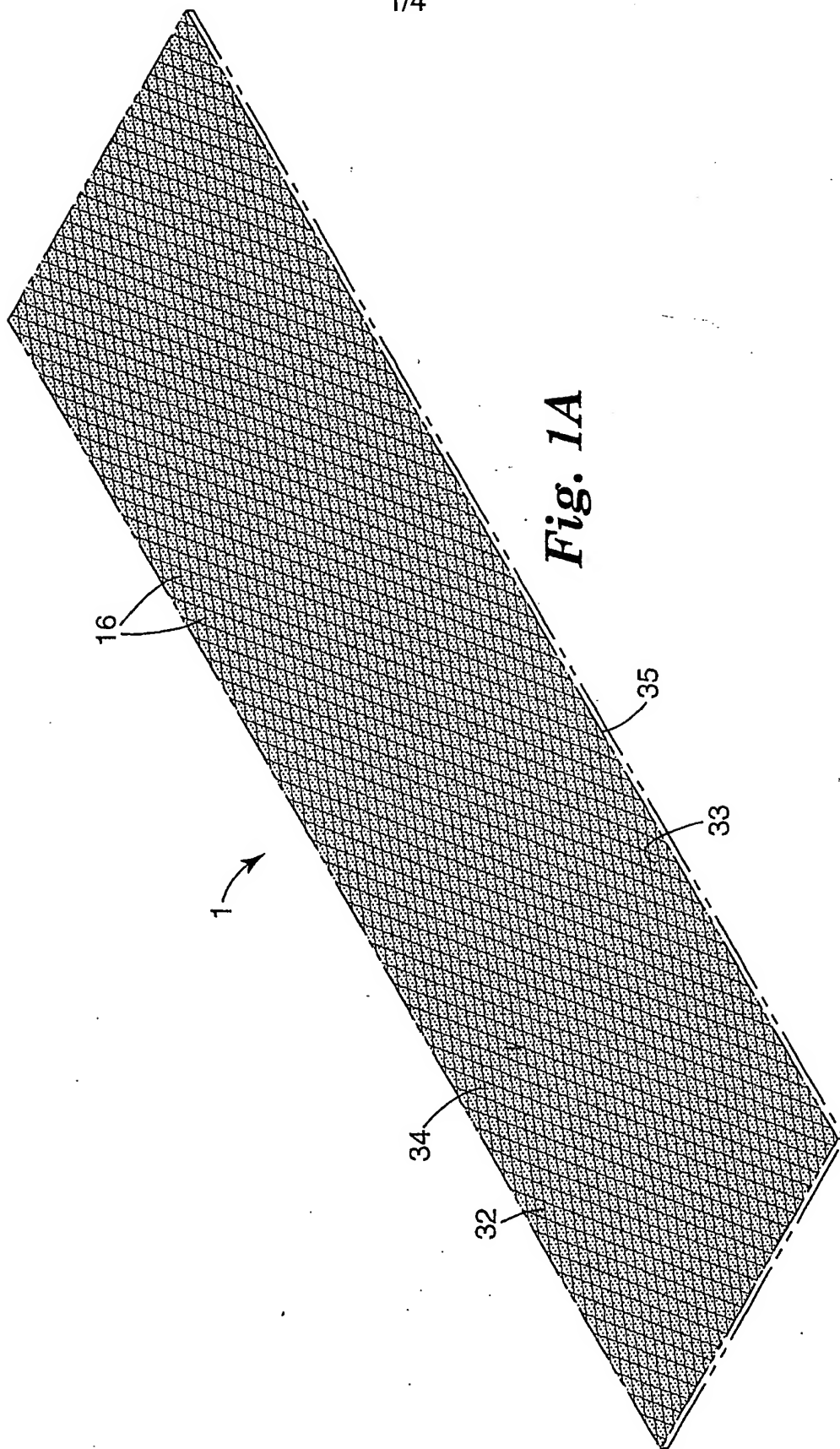
1. A retroreflective cube corner sheeting, comprising:
a cube layer including a viewing surface and a structured surface provided
5 with a plurality of cube corner elements, the cube corner elements
being bounded by at least two intersecting sets of parallel grooves,
the cube layer also including a metallic film disposed on at least some
of the cube corner elements;
a substantially transparent overlay layer having a front surface and a rear
10 surface coupled to the viewing surface of the cube layer;
pigmented indicia disposed on the overlay layer; and
wherein the pigmented indicia is aligned with at least one of the sets of
grooves.
- 15 2. The sheeting of claim 1, wherein the pigmented indicia is disposed between
the rear surface of the overlay layer and the viewing surface of the cube layer.
3. The sheeting of claim 1, wherein at least portions of the overlay layer contact
the viewing surface of the cube layer.
- 20 4. The sheeting of claim 1, wherein the cube layer comprises a substantially flat
film.
5. The sheeting of claim 1, wherein the at least two intersecting sets of parallel
25 grooves consists essentially of three intersecting sets of parallel grooves.
6. The sheeting of claim 1, wherein the pigmented indicia is diffusely reflective.
7. The sheeting of claim 1, wherein the indicia consists essentially of two
30 intersecting sets of parallel stripes.
8. The sheeting of claim 7, wherein each of the intersecting sets of parallel
stripes is substantially parallel to one of the sets of parallel grooves.

9. The sheeting of claim 7, wherein two of the sets of intersecting grooves intersect at an angle θ , and two of the sets of parallel stripes also intersect at substantially the angle θ .
- 5 10. The sheeting of claim 9, wherein the pigmented indicia is substantially white.
11. The sheeting of claim 7, wherein the stripes have a substantially uniform stripe width.
- 10 12. The sheeting of claim 11, wherein the stripe width is from about 0.1 mm to about 2.0 mm.
13. The sheeting of claim 1, wherein the pigmented indicia covers from about 15 10% to about 80% of the viewing surface of the cube layer.
14. The sheeting of claim 1, wherein the overlay layer includes a transparent film comprising polyethylene terephthalate.
- 20 15. The sheeting of claim 1, wherein the overlay layer comprises a PET/COPET bilayer film having a COPET layer in contact with the viewing surface of the cube layer.
- 25 16. The sheeting of claim 15, wherein the pigmented indicia is disposed on the COPET layer of the PET/COPET bilayer.
17. The sheeting of claim 15, wherein at least one of the PET layer and the COPET layer of the PET/COPET bilayer includes an ultraviolet stabilizer.
- 30 18. The sheeting of claim 17, wherein the ultraviolet stabilizer is a triazine.
19. The sheeting of claim 15, wherein at least one of the PET layer and the COPET layer of the PET/COPET bilayer includes a hindered amine light stabilizer.

20. A method of making a retroreflective cube corner sheeting, comprising;
applying a pigmented material to an overlay layer in the form of intersecting
sets of parallel stripes; and
laminating the overlay layer to a cube layer such that the pigmented material
is sandwiched between the overlay layer and the cube layer.
21. The sheeting of claim 20, wherein two of the sets of intersecting grooves
intersect at an angle θ , and two of the sets of parallel stripes also intersect at substantially the
angle θ .
22. The sheeting of claim 20, wherein the intersecting sets of parallel stripes
consist essentially of two intersecting sets of parallel stripes.
23. A retroreflective sheeting, comprising:
a retroreflective layer;
an overlay disposed on the retroreflective layer, the overlay comprising
an inner layer disposed on the retroreflective material and an
outer layer disposed on the inner layer;
wherein the inner layer comprises a copolyester film and wherein the
outer layer comprises a polyester film.
24. The retroreflective sheeting of claim 23 wherein a copolyester resin is
coextruded with a polyester resin to form the overlay.
25. The retroreflective sheeting of claim 23 wherein the copolyester film
comprises a copolyethylene terephthalate and the polyester film comprises a
polyethylene terephthalate.
26. The retroreflective sheeting of claim 23 wherein at least one of the
copolyester film and the polyester film includes a triazine ultraviolet stabilizer.
27. The retroreflective sheeting of claim 26 wherein the triazine ultra violet
stabilizer has a broad-band ultraviolet absorption peak between 300-360 nm.

28. The retroreflective sheeting of claim 26 wherein at least one of the copolyester film and the polyester film includes a hindered amine light stabilizer.
- 5 29. The retroreflective sheeting of claim 28 wherein the hindered amine light stabilizer includes a polymeric compound made of substituted hydroxypiperidines.
30. The retroreflective sheeting of claim 29 wherein the polymeric compound made of substituted hydroxypiperidines includes a polycondensation product of a
10 hydroxypiperidines with one of succinic acid and triazine.
31. The retroreflective sheeting of claim 23 wherein the retroreflective layer includes a cube corner layer having a structured surface opposite a viewing surface, and wherein the copolyester film is disposed on the viewing surface.
15
32. The retroreflective sheeting of claim 31 wherein the cube corner layer includes a titanium metal disposed on the structured surface.
33. The retroreflective sheeting of claim 23 wherein pigmented indicia are
20 disposed between the copolyester film and the retroreflective layer.
34. The retroreflective sheeting of claim 33 wherein a transparent color layer is disposed between the copolyester film and the retroreflective layer.
- 25 35. The retroreflective sheeting of claim 34 wherein the transparent color layer is disposed on the copolyester film and between the copolyester film and the pigmented indicia.

1/4



2/4

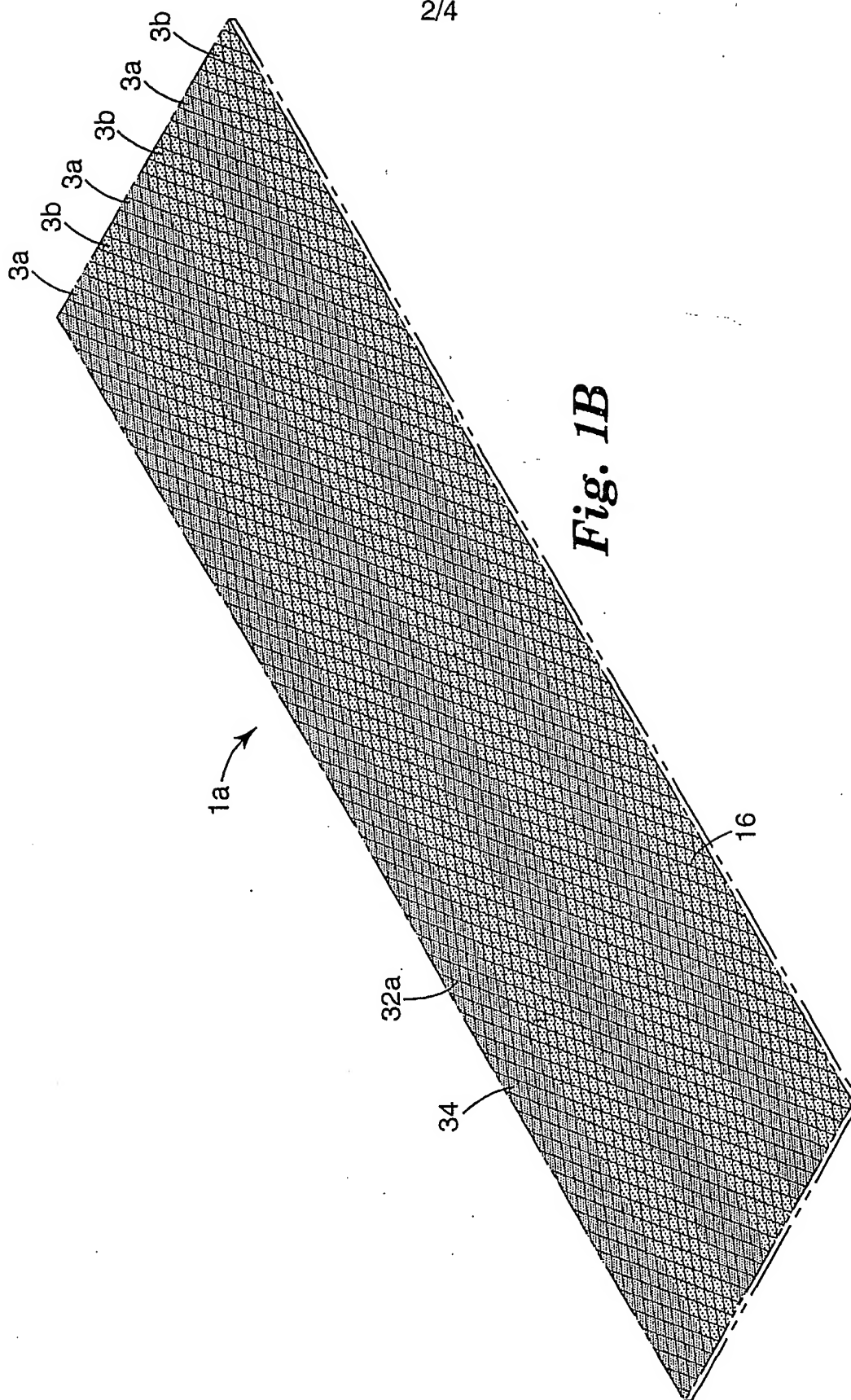


Fig. 1B

3/4

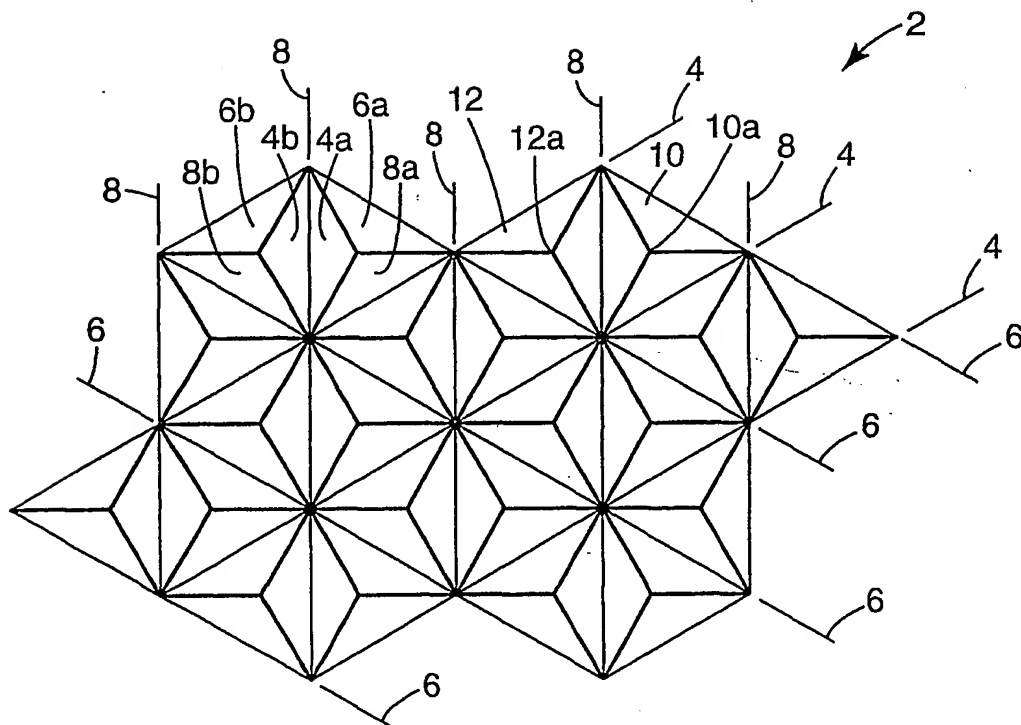


Fig. 2

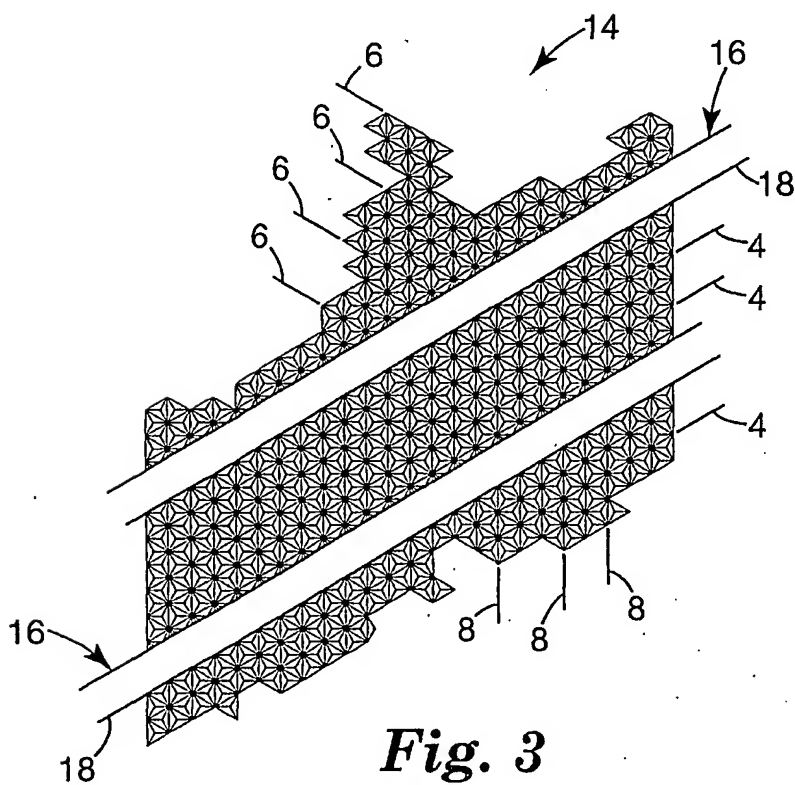
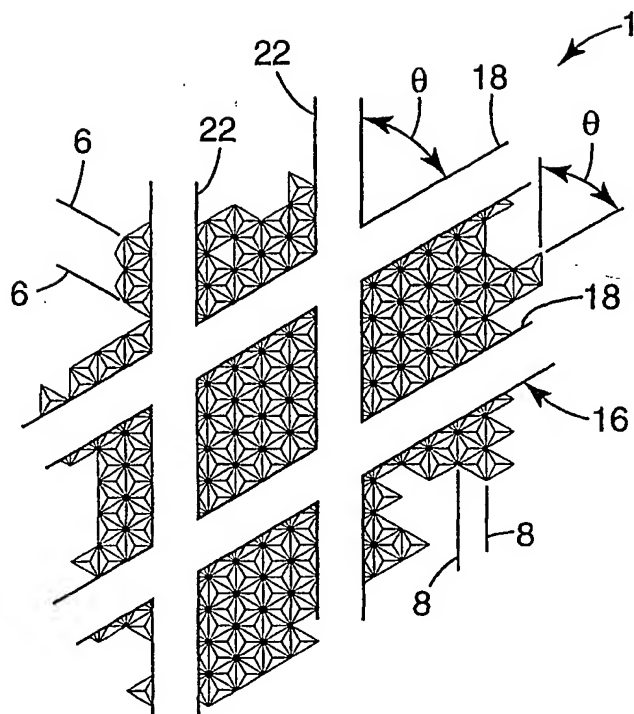
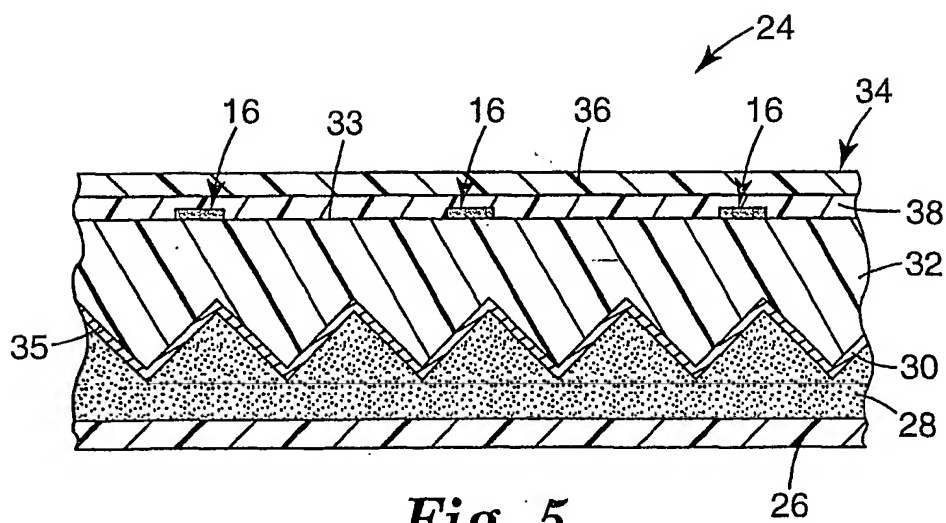


Fig. 3

4/4

*Fig. 4**Fig. 5*

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
25 October 2001 (25.10.2001)

PCT

(10) International Publication Number
WO 01/079897 A3

(51) International Patent Classification⁷: **G02B 5/124**

(21) International Application Number: **PCT/US01/07341**

(22) International Filing Date: **7 March 2001 (07.03.2001)**

(25) Filing Language: **English**

(26) Publication Language: **English**

(30) Priority Data:
09/548,894 **13 April 2000 (13.04.2000)** **US**

(71) Applicant: **3M INNOVATIVE PROPERTIES COMPANY [US/US]**; 3M Center, Post Office Box 33427, Saint Paul, MN 55133-3427 (US).

(72) Inventors: **CODERRE, James, C.**; Post Office Box 33427, Saint Paul, MN 55133-3427 (US). **CHIRHART, Dennis, J.**; Post Office Box 33427, Saint Paul, MN 55133-3427 (US). **FRANK, John, W.**; Post Office Box 33427, Saint Paul, MN 55133-3427 (US). **JOHNSON, Stephen, A.**; Post Office Box 33427, Saint Paul, MN 55133-3427 (US). **MCGURRAN, Daniel, J.**; Post Office Box 33427, Saint Paul, MN 55133-3427 (US).

(74) Agents: **HOFMANN, Rudolph, P., Jr. et al.**; Post Office Box 33427, Saint Paul, MN 55133-3427 (US).

(81) Designated States (*national*): AE, AG, AL, AM, AT (utility model), AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ (utility model), CZ, DE (utility model), DE, DK (utility model), DK, DM, DZ, EE (utility model), EE, ES, FI (utility model), FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK (utility model), SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW.

(84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

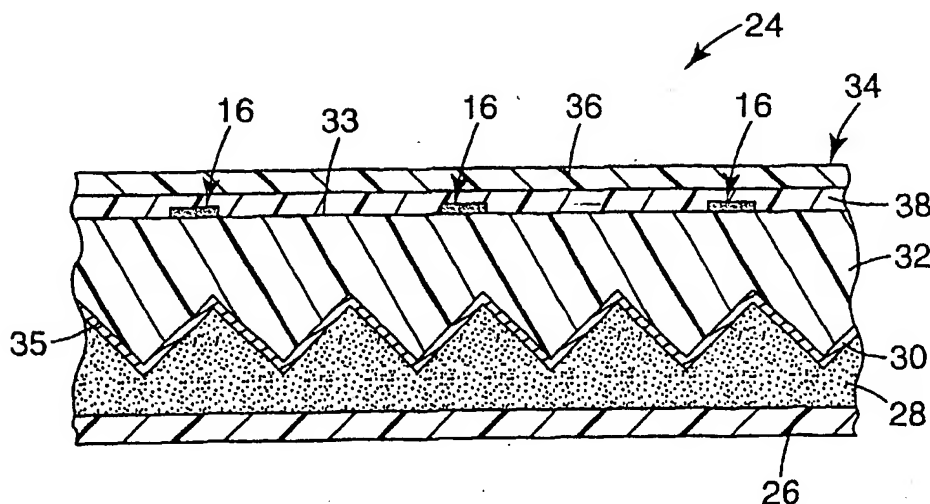
Published:

— with international search report

(88) Date of publication of the international search report:
6 February 2003

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: **CUBE CORNER RETROREFLECTIVE ARTICLE WITH ENHANCED PIGMENTATION**



(57) Abstract: Retroreflective sheeting includes a transparent film, a pigmented layer having pigmented indicia thereon, and a retroreflective cube layer. The cube layer includes a number of cube corner elements bounded by at least two sets of intersecting grooves. A metallic film is disposed on at least some of the cube corner elements. The pigmented layer is interposed between the transparent film and the cube layer, and has pigmented indicia aligned with at least one of the sets of intersecting grooves.

WO 01/079897 A3

INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 01/07341

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 G02B5/124

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 G02B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EP0-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 99 37470 A (REFLEXITE CORP) 29 July 1999 (1999-07-29) page 8, line 7 -page 10, line 23 page 16, line 27 -page 17, line 21 figures 4,7	1-6,14
Y	WO 93 14422 A (STIMSONITE CORP) 22 July 1993 (1993-07-22) page 2, line 23 -page 3, line 6 page 6, line 23 -page 7, line 11 page 7, line 27 - line 34; claims 11,13	1,2,4,5
Y	US 5 272 562 A (CODERRE JAMES C) 21 December 1993 (1993-12-21) abstract; figure 4	1,2,4,5

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

28 August 2002

Date of mailing of the international search report

02.10.2002

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Mollenhauer, R

INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 01/07341

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 99 40461 A (MINNESOTA MINING & MFG) 12 August 1999 (1999-08-12) page 347, line 16 - line 23; figure 2 ---	1
A	EP 0 555 847 A (MINNESOTA MINING & MFG) 18 August 1993 (1993-08-18) page 2, line 56 - line 58 ---	1
A	WO 99 36806 A (MINNESOTA MINING & MFG) 22 July 1999 (1999-07-22) page 28, line 23 -page 29, line 4 ---	15,23
P,A	WO 00 54079 A (REFLECTIVE TECHNOLOGY IND LTD ;WINDRIDGE MARTIN HAROLD (GB); SAGAR) 14 September 2000 (2000-09-14) page 3, paragraph 4 - paragraph 5 -----	23

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 01/07341

Box I Observations where certain claims were found unsearchable (Continuation of Item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this International application, as follows:

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☒ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-14,20,21

Retroreflective cube corner sheeting with the cube corner elements being bound by at least two intersecting sets of parallel grooves and a metallic film disposed on at least some of the elements, a substantially transparent overlay layer coupled to the viewing surface of the cube layer and two intersecting parallel pigmented indicia stripes disposed on the overlay layer and aligned with at least one set of grooves and method of making it.

2. Claims: 15-19,23-35

Retroreflective cube corner sheeting with the cube corner elements being bound by at least two intersecting sets of parallel grooves and a metallic film disposed on at least some of the elements, a substantially transparent overlay layer coupled to the viewing surface of the cube layer and comprising a bilayer.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 01/07341

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
WO 9937470	A	29-07-1999	US 6119751 A	19-09-2000
			US 6120636 A	19-09-2000
			CA 2318039 A1	29-07-1999
			EP 1051291 A1	15-11-2000
			JP 2002500969 T	15-01-2002
			WO 9937470 A1	29-07-1999
WO 9314422	A	22-07-1993	AU 3436393 A	03-08-1993
			CA 2128113 A1	22-07-1993
			CN 1075374 A	18-08-1993
			EP 0631670 A1	04-01-1995
			MX 9300209 A1	01-07-1993
			NZ 246793 A	27-08-1996
			PL 171563 B1	30-05-1997
			US 5415911 A	16-05-1995
			WO 9314422 A1	22-07-1993
			ZA 9300314 A	19-08-1993
US 5272562	A	21-12-1993	AT 195376 T	15-08-2000
			AU 661217 B2	13-07-1995
			AU 5280893 A	11-08-1994
			BR 9400370 A	23-08-1994
			CA 2112524 A1	06-08-1994
			CN 1099872 A ,B	08-03-1995
			DE 69425448 D1	14-09-2000
			DE 69425448 T2	29-03-2001
			EP 0609880 A1	10-08-1994
			JP 6250006 A	09-09-1994
WO 9940461	A	12-08-1999	US 6282026 B1	28-08-2001
			AU 7824498 A	23-08-1999
			CA 2318428 A1	12-08-1999
			CN 1284173 T	14-02-2001
			EP 1053491 A1	22-11-2000
			JP 2002502984 T	29-01-2002
			TW 416009 B	21-12-2000
			WO 9940461 A1	12-08-1999
EP 0555847	A	18-08-1993	US 5200851 A	06-04-1993
			CA 2088628 A1	14-08-1993
			DE 69309983 D1	28-05-1997
			DE 69309983 T2	18-12-1997
			EP 0555847 A2	18-08-1993
			JP 5346767 A	27-12-1993
WO 9936806	A	22-07-1999	US 6024455 A	15-02-2000
			AU 738111 B2	06-09-2001
			AU 1812699 A	02-08-1999
			BR 9814000 A	10-10-2000
			CA 2316266 A1	22-07-1999
			CN 1285047 T	21-02-2001
			EP 1047960 A1	02-11-2000
			JP 2002509277 T	26-03-2002
			WO 9936806 A1	22-07-1999
WO 0054079	A	14-09-2000	GB 2347366 A	06-09-2000
			AU 3173400 A	28-09-2000
			WO 0054079 A1	14-09-2000

**This Page is Inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record**

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ **BLACK BORDERS**
- ☐ **IMAGE CUT OFF AT TOP, BOTTOM OR SIDES**
- ☐ **FADED TEXT OR DRAWING**
- ☐ **BLURRED OR ILLEGIBLE TEXT OR DRAWING**
- ☐ **SKEWED/SLANTED IMAGES**
- ☐ **COLOR OR BLACK AND WHITE PHOTOGRAPHS**
- ☐ **GRAY SCALE DOCUMENTS**
- ☐ **LINES OR MARKS ON ORIGINAL DOCUMENT**
- ☐ **REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY**
- ☐ **OTHER:** _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.